

SEWALL'S FALLS HYDROELECTRIC FACILITY
(Sewall's Falls Dam)
East end of Second Street
spanning the Merrimack River
Concord
Merrimack County
New Hampshire

HAER No. NH-20

HAER
NH
7-CON,
11-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106

HISTORIC AMERICAN ENGINEERING RECORD

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Photographer: (Views 1-26) Dennis E. Howe
(Views 27-40) Dennis E. Howe
(Views 41-54) Dennis E. Howe

July 5, 1992
Sept. 5, 1992
Nov. 5, 1992

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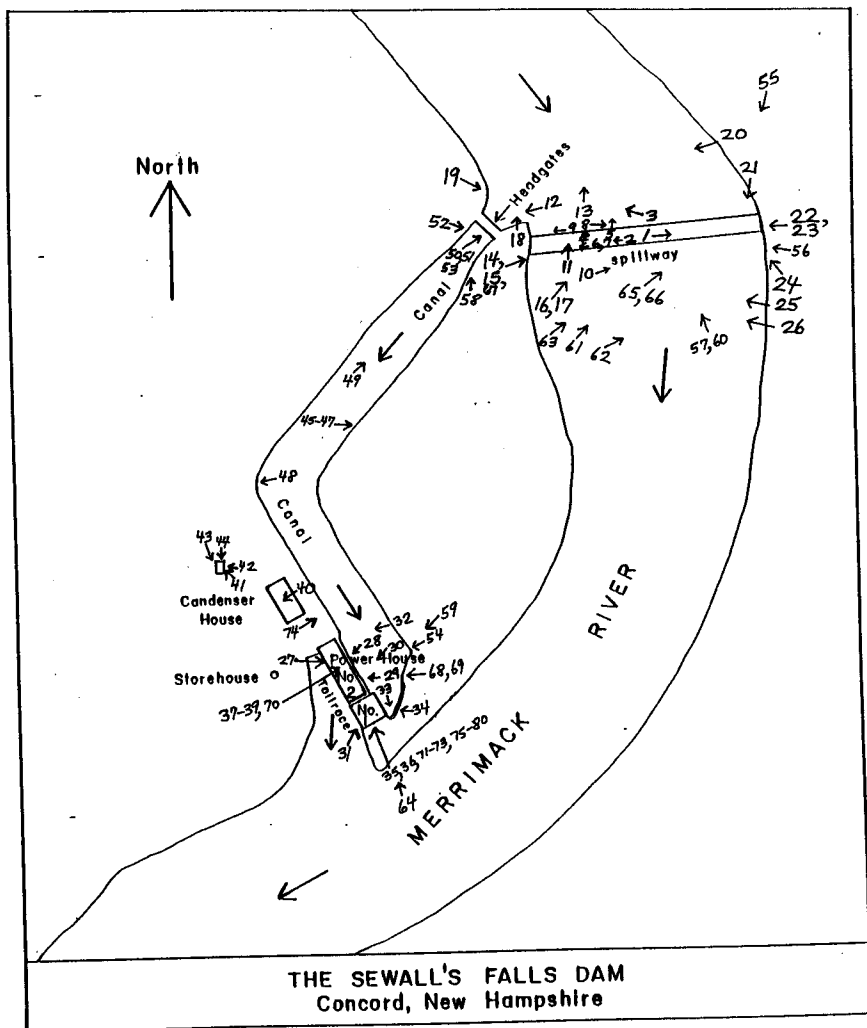
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(Sewall's Falls Dam)

Location: East end of Second Street, spanning the Merrimack River
Concord
Merrimack County
New Hampshire

UTM: 18.29265.479245
Quad: Pennacook, NH

Date of Construction: 1892-1894

Engineer: E. F. Smith
Architect: William H. Ward

Present Owner: State of New Hampshire
Fish and Game Department
2 Hazen Drive
Concord, New Hampshire 03301

Present Use: Hydroelectric Facility; spillway washed out in April of 1984.

Significance: The Sewall's Falls Dam in Concord, New Hampshire, was one of the longest timber crib dams in the eastern United States. On September 29, 1893, this became the second commercial supplier of three-phase electric current in the United States. The dam remained intact until 1984, at which time the mid-section washed away.

Project Information: The New Hampshire Fish and Game Department proposes to place fill in wetlands and below the ordinary high water level of the Merrimack River for the stabilization of the remains of the Sewall's Falls Dam and to provide human and boat access to the Merrimack River off Sewall's Falls Road in Penacook, New Hampshire. To mitigate the adverse effect, the NH Division of Historical Resources recommended on April 3, 1991 that historic documentation be provided in the form of written, graphic and photographic documentation of the Sewall's Falls Hydroelectric Facility. This documentation was undertaken to satisfy this requirement.

David R. Starbuck
P.O. Box 147
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Historical Background

Timber crib dams are typically built across streams to generate waterpower. Part of the flow is diverted into a power canal, whereas excess water flows over the top of squared timber cribbing which forms the spillway. Large stones are packed inside the cribbing to make the dam strong enough to withstand the impact of floods and ice rafting. Sometimes these dams are straight, and sometimes they are slightly convex upstream. Often an inclined plane (or "apron") is constructed upstream of the dam so that the force of the water cannot undermine the structure, and a second inclined plane is needed on the downstream side so as to break the fall of the water. When a timber dam is especially important or is meant to be particularly long-lasting, then the abutments that anchor the ends of the dam to its riverbanks are built of solid masonry. This prevents leakage around the ends of the dam. Another possibility is that sturdy sheet-piles may be driven into the bottom of the river to help anchor the dam.¹

While some of the longest timber crib dams were constructed across rivers in the western United States,² easily the longest such dam in the east was built at a falls on the Merrimack River in Concord, New Hampshire. Known as the "Sewall's Falls Dam" and positioned at the eastern end of Second Street in Concord, this was formerly a popular fishing site for the Penacook Indians (a tribe of the Western Abenaki) and the site of a European trading post in the 1650s.³ Later, Judge Samuel Sewall purchased land in the vicinity of the falls, giving the site its name, and then the first white settlers arrived here in 1726.

Much later, in 1833, the New Hampshire Legislature granted a charter to the Proprietors of Sewall's Falls Locks and Canal, "empowering them to build a canal from the head of Sewall's Falls to the mouth of Mill Brook, a distance of about two miles."⁴ This was to have been a transportation canal, and the adjoining property was to have been developed for mill sites. The company partially dug the canal but finally gave up and lost about \$80,000. It was the first of several companies to incorporate for the purpose of developing the Falls, but each failed.

The next effort was made in 1871, when the New Hampshire Legislature granted a charter to the Sewall's Falls Transmitting Power Company, whose purpose was "to develop the water-privilege and to transmit power to the city of Concord by a vague scheme for compressing air."⁵ Their intent was to erect a dam, they were capitalized with \$500,000, but they never began construction.

The next company to contemplate a dam at Sewall's Falls was the Sewall's Falls Land & Water Power Company. They incorporated in 1881, acquired title to the water privilege, and purchased land on both sides of the Merrimack River. An assessment of the falls was conducted that year by Ray T. Gile, C.E., who concluded that,

the total fall in a distance of about one mile and a half is found to be 19 3/4 feet, thus furnishing ample power for all the manufactories that would ever be located there. The width of the river at the point where the dam would probably be built is such as to require a dam 350 feet in length. The cut granite already on the ground in the abutments

built by the old canal company is sufficient to build more than half of a dam of this length. The deepest cut that would have to be made for the flume would be 27 feet The bed of the river, though not a ledge is found to be solid and unusually favorable for the construction of a dam. The soil bordering upon the Falls is light and of such a nature as to make the work of cutting canal, making excavations, etc., very easy.⁶

In spite of this most positive assessment, the Sewall's Falls Land & Water Power Company was bought out in a matter of months by the Concord Land & Water Power Company. Incorporated on November 5, 1881, this new company acquired the water privilege and planned the creation of an entire community which would receive its power from a dam and canal. Although they, too, failed, it was significant that George and Charles Page, founders of the Page Belting Company, were behind this effort. For 10 years they tried to raise funding for a dam, but it was not until July 22, 1892 that the Concord Land & Water Power Company was again incorporated, still with the Pages as primary officers. Their intent was to generate electricity for arc lights, incandescent bulbs and electric motors, and they acquired all of the holdings of the previous company, along with 700 acres of land on either side of the river.⁷

In August of 1892 they began construction of a timber crib dam across the Merrimack, but their coffer dam washed out in October during high water, and they were unable to finish the dam until the spring of 1893. In the following year they completed the construction of a canal and powerhouse (No. 2 Station) and installed turbines, shafting and electrical equipment. It was during this period that the Concord Land & Water Power Company began to supply three-phase electric current over a three-phase line to a five horsepower induction motor set up in the machine shop of N.P. Stevens in Concord. (The motor was later given to General Electric in Schenectady, where it was put on exhibit.) The multiphase system began operation at Sewall's Falls on September 29, 1893, and only the Redlands Electric Light and Power Company in Redlands, California, can claim to have been a few weeks earlier in operating a three-phase system for commercial purposes.⁸ There were, however, earlier uses of the three-phase system, in the GE and Westinghouse shops and at the 1893 Columbian Exposition in Chicago, and a few synchronous motors also operated slightly earlier.

A transmission line from Sewall's Falls to the City of Concord was completed in February of 1894, and on February 28, 1894 the public was invited to the site to watch the water flow into the power canal. According to a local newspaper, a train carried sightseers from Concord to the dam site, a crowd of 500-600 people gathered at the headgates, and at 10 A.M. "the workmen applied their levers to the lifting apparatus, the center gate lifted, and a solid stream of water two feet by three feet rushed out into the canal".⁹ The paper went on to state that inside the powerhouse,

The large triphase dynamo was the object of much interest. Not all the machinery has yet been placed in position, but in 10 days it is expected that the lights for the city will be furnished direct from the falls.¹⁰

A few days later the Concord Land & Water Power Company was, in fact, delivering power to the City of Concord.

Floods in 1895 and 1896 caused extensive damage to the middle and lower aprons of the dam, and in 1896 the cribs were repaired and the surfaces were replanked with Georgia pine.¹¹ It was not long, though, before the company ran into financial problems, went into receivership, and then on July 1, 1901, the Concord Electric Company was organized to take over the operation. After that time the dam, canal, and powerhouse were maintained in their original form, except that the canal was widened and the dam strengthened. As noted by R.G. Knowlton, "When the Concord Electric Company first started operations in 1901, it is believed that there were 22 employees and only 222 customers . . .," but "In 1905 the plant at Sewalls Falls was expanded and the capacity of its generators was doubled from 1000 to 2000 KW."¹² This expansion is described in the following passage:

The new installation consists of two units, each consisting of 3--55" bronze runners of the Francis type, mounted on a vertical shaft and hung on a step bearing. The machines are of the Escher-Wyss type built by the Allis Chalmers Company, American representatives of the Escher-Wyss Co. The gates are of wicket pattern, controlled by Escher-Wyss mechanical governors, also built by The Allis Chalmers Company. The generators, which are direct connected to the vertical shaft wheels, are of 500 k.w., 3-phase, 60 cycle, 2,000 volt, 100 r.p.m., revolving field type. Excitation is furnished by one 75 h.p., 3-phase, 2,600 volt induction motor, direct connected to a 45 k.w., 125 volt, compound wound D.C. generator. The exciter unit runs at 680 r.p.m.¹³

Soon afterward, a new building was erected in 1908 containing a steam engine (a steam relay plant) for standby service when the waterpower was shut down.¹⁴

After these beginnings, the history of the dam and canal at Sewall's Falls was one of periodic maintenance, typically in the late summer of each year when the river level was at its lowest. Repairs during the 1930s had to be especially extensive because of flooding in 1936 and a hurricane in 1938. On March 20, 1936 "the Merrimack River reached an all-time record of 16.8 feet above the crest at Sewalls Falls",¹⁵ and the wing walls of the dam had to be sandbagged. And then on September 21, 1938, a hurricane caused the river to crest some 13.9 feet above the dam. There were repairs to the dam in 1933 that involved the removal and replacement of approximately 20% of the volume of the timber crib and rock filling. The five wooden gates of the headgate structure were also replaced in 1933.¹⁶

Finally, at the end of the 1966 power year, generation at the hydro plant was suspended because it had become cheaper for the Concord Electric Company to purchase power from the Public Service Company of New Hampshire, which was burning fossil fuel.¹⁷ Then, in 1969, Concord Electric turned over its operating license for the dam to the Federal Power Commission, and the State of New Hampshire purchased the dam for \$1.00. Concord Electric gave the State \$10,000 with which to cover future repair costs for the dam; but the money was deposited in the State's General Fund, the annual maintenance work on the dam ceased, and

the dam was allowed to deteriorate to the point that many individual timbers washed out, weakening the structure.

The final blow came during the night of April 7-8, 1984 when a 100-foot-long section of the dam gave way after several days of heavy rain,¹⁸ and the Merrimack River has been rushing through the breach in the dam ever since. The silt that had been deposited north of the dam has all washed through, much of the timber cribbing has washed out, and with the river level radically lowered, the exposed spillway of the dam is an imposing sight.

Description of the Dam Site

The original drawings of the Sewall's Falls dam and canal were prepared by a civil engineer, E.F. Smith of Philadelphia; the canal was built under the direction of Daniel Ulrich; while the powerhouse was designed by Eugene F. Carpenter. The dam itself was constructed by William H. Ward of Lowell, Massachusetts, and was intended to develop 5000 horsepower.¹⁹ Work on the dam and canal began in August of 1892, and the company ran a track to the dam site in order to supply construction materials. They also set up a temporary arclighting plant so that the work could be continued around the clock,²⁰ and what may be the remains of this plant can now be found several hundred feet to the west of the dam site, where a foundation and the remains of a steam boiler have been located.

The people of Concord were fully aware of the importance of what was being built. In the Concord Evening Monitor of August 8, 1893 this was described as "the finest dam in New England," spanning 497 feet between abutments and with a height of 22 feet. The approximate cost of the dam was \$125,000, and it was predicted to last for at least 40 years. The paper also noted that "Nine times so far the work has been baptized in blood, six of the victims being employed on the dam and three being lumbermen".²¹ Slightly later, on September 29, 1893, the Concord Evening Monitor reported that,

At the Bridge street power house of the Concord Land & Water Power Company this afternoon at 2 o'clock, was made the first practical demonstration of the use of the triphase current system of electric power distribution in the United States, and in fact the first on the American continent.²²

It would thus appear that they were quite unaware of the generation of three-phase current in Redlands, California, just 22 days earlier. Still, if the coffer dam had not washed out in October of 1892, Sewall's Falls would probably have had priority over Redlands by several months.

The Dam

The dam was built in three stages, each about 20 feet wide, with the lowest step being downstream. The top of each step was covered with heavy planks spiked down to the timbers in the cribs, and the spaces inside the cribs were hand-packed with stones. The abutments and wing-walls were made with squared granite blocks laid in cement. The spillway was constructed with 12" x 12" lon-

gitudinal timbers, hemlock and fir, and 10" x 10" crossties fastened with bolts. "About 1,500,000 feet of timber and 20,000 cubic yards of rubble stone were used in the spillway, and 5,000 cubic yards of hammered granite were used for the abutments and headgates".²³

The Headgate Structure

The headgate structure, utilizing five gates with masonry piers between them, is located west of the west granite abutment. Each of the five brick arch conduits has a timber gate approximately 10' wide and 11'5" high. The headgate structure is made of granite blocks, and the hoisting equipment for the gates was operated by a rack and pinion system, powered by electricity. The gatehouse that housed this equipment is now gone, having been burned by vandals. The canal that begins at the headgates runs for a distance of 1280 feet, and water in the canal ran through a 50-foot waste weir (trash rack) at the southern end of the canal into short penstocks and then to the turbines in the two brick powerhouses. The canal is 60 feet wide and 13 feet deep at its center, and it has an L-shape--it bends sharply in the middle. The sides of the canal are "formed of wooden criba buried in earth embankments, with vertical sheet-piling spiked to the canal faces of the crib".²⁴ After water passed through this channel and through the powerhouses, it then was carried by a tailrace channel, approximately 200 feet long, back to the river.

Powerhouse No. 2

In the original powerhouse (No. 2 Station), there were five wheel-cases with draft tubes, four of which had a pair of wheels (turbines). This first powerhouse utilized Rodney Hunt turbines. The water wheels were in the basement of the powerhouse, and belting extended upward through the operating floor to the shafting. There were four 3-phase generators made by General Electric, rated at 225 kilowatts each and operating at 2,300 volts and 50 cycles. (The current "alternated" 100 times/second so there were 50 cycles/second.) There were two Edison bi-polar dynamos used as exciters, and five Thompson-Houston arc-light dynamos. Transmission lines were carried across the river, through East Concord, and then south to the city of Concord.

Powerhouse No. 1

A second powerhouse (No. 1 Station) was built in 1905, and it became completely operational in 1907. The turbines in No. 1 Station were built by the Allis-Chalmers Company (two Allis-Chalmers triplex turbines of 900 horsepower each).²⁵ All generating equipment was finally removed from the powerhouses when they were decommissioned in the mid-1960s. Both powerhouses are presently used as storage space by the New Hampshire Water Resources Board, and wooden flooring overlies the penstocks and draft tubes which are still intact.

Wooden Spillway

When the wooden spillway washed out in 1984, it split the dam into two sections, and the span of the western section is approximately 250 feet, while the

eastern section is approximately 50 feet. The first apron and second apron of the spillway are clearly visible, although in poor condition, and much of the steel nosing (1/4" thick x 24" x 42") is still present which protected the timbers from ice flows. Remains of the cofferdam--which channeled water toward the power canal--are still visible in front of (north of) the western section of the spillway, and a couple of "deadmen" (logs used as an anchor for guy ropes) are still positioned north of the spillway. At the present time the top of the spillway is approximately 15 feet above the current water line in the Merrimack River. Only the dam's east and west abutments--rising 14 feet above the crest of the dam--are as sturdy as ever, and both abutments are flanked on the south with piles of granite quarry waste (rip-rap).

Notes

1. Edward Wegmann, The Design and Construction of Dams (New York: John Wiley & Sons, 1927), pp. 280-281. Also see James Leffel, Construction of Mill Dams (James Leffel & Co., 1881; reprinted by Noyes Press, 1972).
2. Prominent among the western timber crib dams was one in excess of 500 feet that was built across the Salt River near Phoenix, Arizona, in the 1890s. This was later replaced in 1908 by a concrete dam, the 1000-foot-long Granite Reef Dam. See Donald C. Jackson, Great American Bridges and Dams (Washington, D.C.: The Preservation Press, 1988), pp. 246-247, and Donald C. Jackson, personal communication, Feb. 28, 1991. Also significant was the Canyon Ferry Dam built in 1898 across the Missouri River in Montana. This timber crib dam was 485 feet long and 29 feet high; see Wegmann (n. 1 above), p. 293.
3. Nathaniel Bouton, The History of Concord ... with a History of the Ancient Penacooks (Concord: B.W. Sanborn, 1856); James O. Lyford, ed., History of Concord, New Hampshire (Concord: The Rumford Press, 1903); David R. Starbuck, "Excavations at Sewall's Falls (NH31-30) in Concord, New Hampshire," The New Hampshire Archeologist 23 (1982):1-36.
4. George B. Lauder, "The Story of Sewall's Falls," manuscript in the collections of the Concord Electric Company (Concord, N.H., 1938), p. 3.
5. Ibid., p. 3.
6. "Sewall's Falls," Independent Statesman (October 20, 1881).
7. Lauder (n. 3 above), p. 3.
8. The Redlands Electric Light and Power Company began to generate three-phase AC power on Mill Creek in Redlands, California, on September 7 of 1893. Both the Redlands and Concord power transmission plants received their technology from General Electric in Schenectady, New York. See "The First Three-Phase Transmission Plant in the United States," Electrical Review 23 (Nov. 29, 1893):179; and Donald C. Jackson, A History of Water in the American West: John S. Eastwood and "The Ultimate Dam" (1908-1924), Ph.D. diss.

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9. "The Water Turned on Sewalls Falls," Concord Evening Monitor (February 28, 1894), p. 8.
10. Ibid., p. 8.
11. George B. Lauder, "Sewall's Development," manuscript in the collections of the Concord Electric Company (Concord, N.H., 1935), p. 17.
12. R. G. Knowlton, "Brief History of Concord Electric Co.," manuscript in the collections of the Concord Electric Company (Concord, N.H., 1961), p. 3.
13. Engineering Record (January 6, 1906) and reprinted in Daniel W. Mead, Water Power Engineering (New York: McGraw-Hill Book Co., 1908), p. 553.
14. Knowlton (n. 12 above), p. 3; Lauder (n. 11 above), p. 45.
15. Ibid., p. 5.
16. Lauder (n. 3 above), p. 60.
17. Douglas K. Macdonald, "An Up-date of the History of Concord Electric Company, Prepared by Mr. R. G. Knowlton in 1961," manuscript in the collections of the Concord Electric Company (Concord, N.H., 1983).
18. Sharon Voas, "Wood Dam Gives Way in Concord," Concord Monitor (Monday, April 9, 1984), pp. 1, 14.
19. "Concord Land & Water Power Company," Concord Evening Monitor (Oct. 1, 1892), p. 7.
20. Lauder (n. 3 above), p. 12.
21. "Water Flows Over. Progress of the Work at the Sewall's Falls Dam," Concord Evening Monitor (Aug. 8, 1893), p. 8.
22. "Triphase Electric Distribution," Concord Evening Monitor (Sept. 29, 1893), p. 8.
23. "Sewall's Falls Request for Determination of Eligibility," manuscript prepared by Rivers Engineering Corporation (1983).
24. Lauder (n. 11 above), p. 14.
25. Lauder (n. 11 above), p. 36.

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- William E. Virgin Collection, New Hampshire Historical Society, Concord, New Hampshire. Collection of photographs taken by William E. Virgin in the 1890s.

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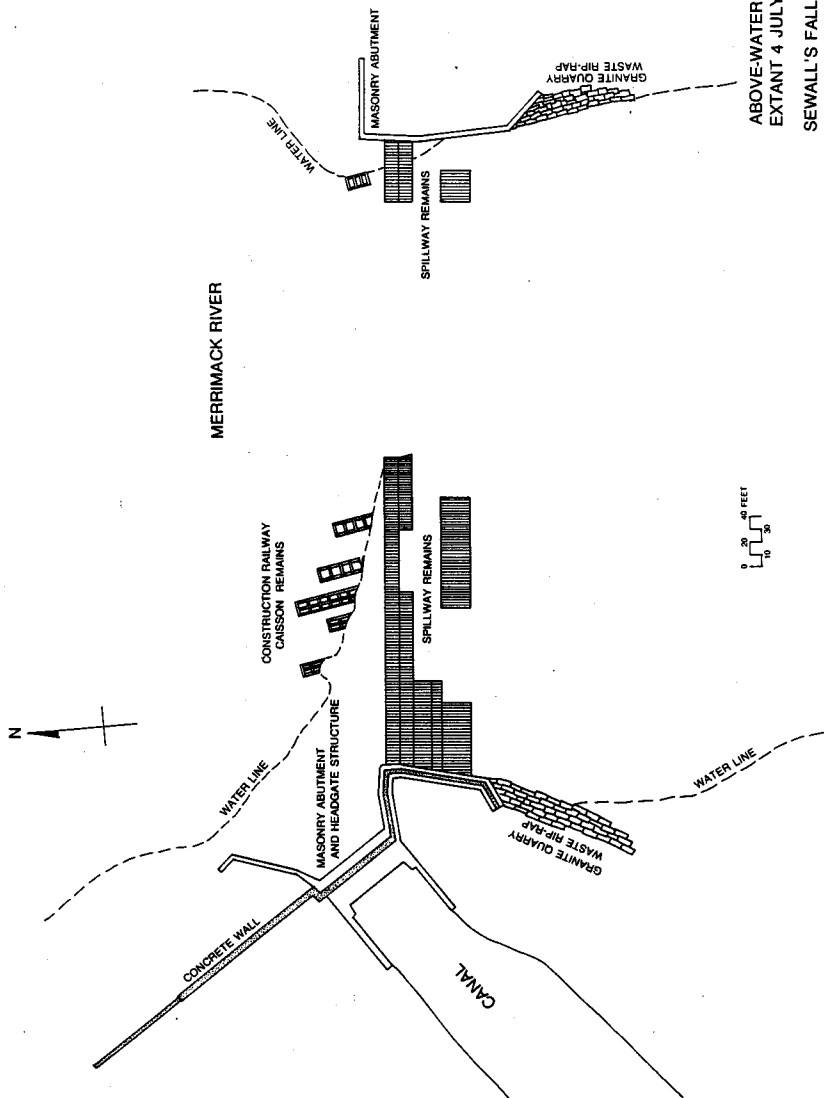
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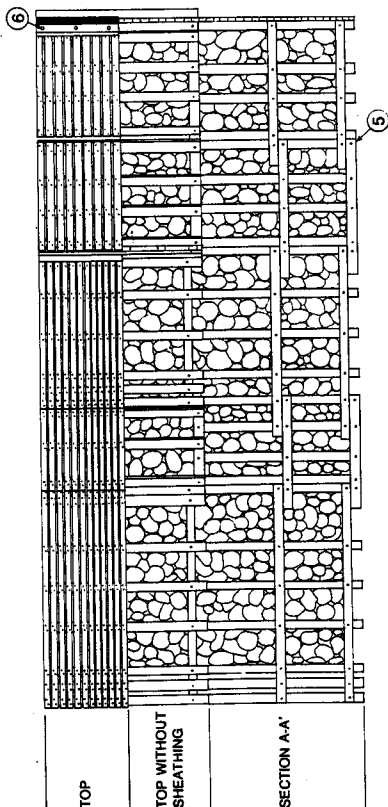
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HAER No. NH-20 (Page 12)

ABOVE-WATER DAM REMAINS
EXTANT 4 JULY 1982
SEWALL'S FALLS HYDROELECTRIC
FACILITY - NPS804



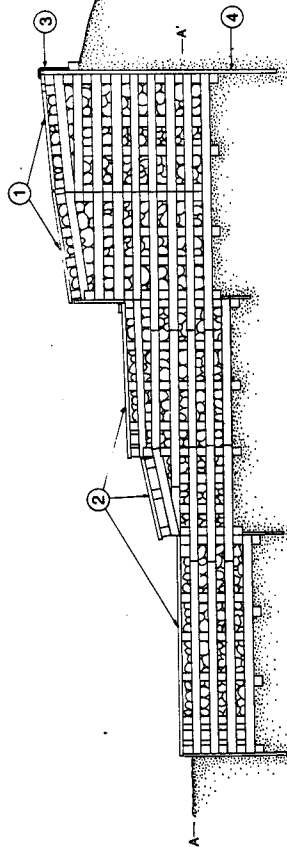
PLAN



NOTES

1. SPILLWAY: PLANK SHEATHING, 5" THICK, 7" WIDE.
2. SPILLWAY: PLANK SHEATHING, 4" THICK, 8" WIDE.
3. ICE SHIELD: IRON PLATE, 1/4" X 24" X 42", BENT ON 6" RADIUS AT 32", SECURED WITH IRON SPIKES.
4. SHEET PILING: PLANK SHEATHING, 4" THICK, 8" WIDE.
5. SQUARED FIR TIMBER CRIBBING, SECURED WITH WROUGHT IRON PINS, 3/4" DIA. 24" TO 36" LONG.
6. 1-3/4" DIA. BORED HOLES SPACED AT APPROX. 40". IRON PIPE, 1/8" WALL THICKNESS, WAS INSERTED INTO HOLES TO SUPPORT FLASHBOARDS.

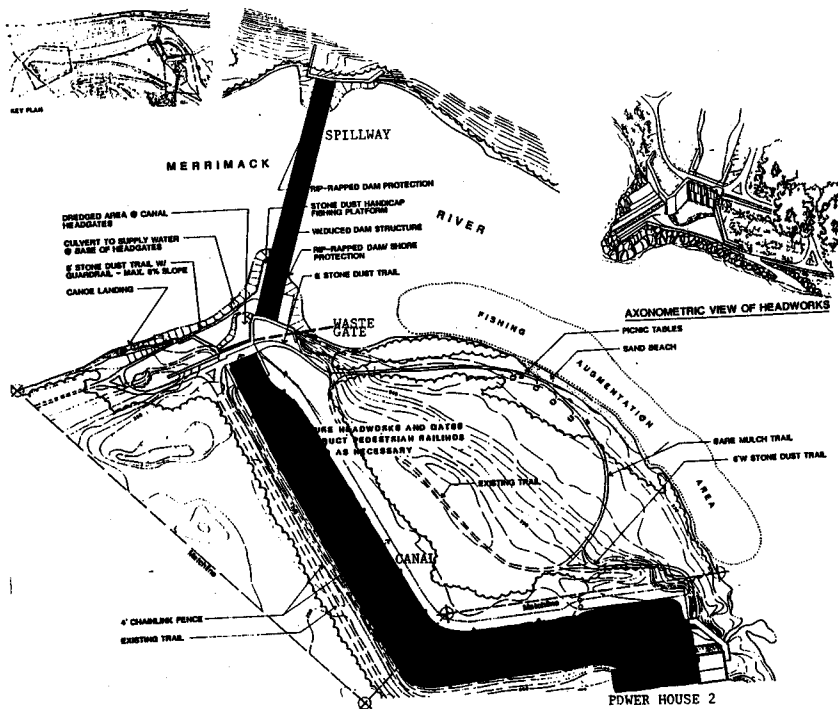
PROFILE



ROCK-FILLED TIMBER CRIB DAM
CONSTRUCTION DETAIL
INTERPRETED FROM REMAINS
EXTANT 4 JULY 1992

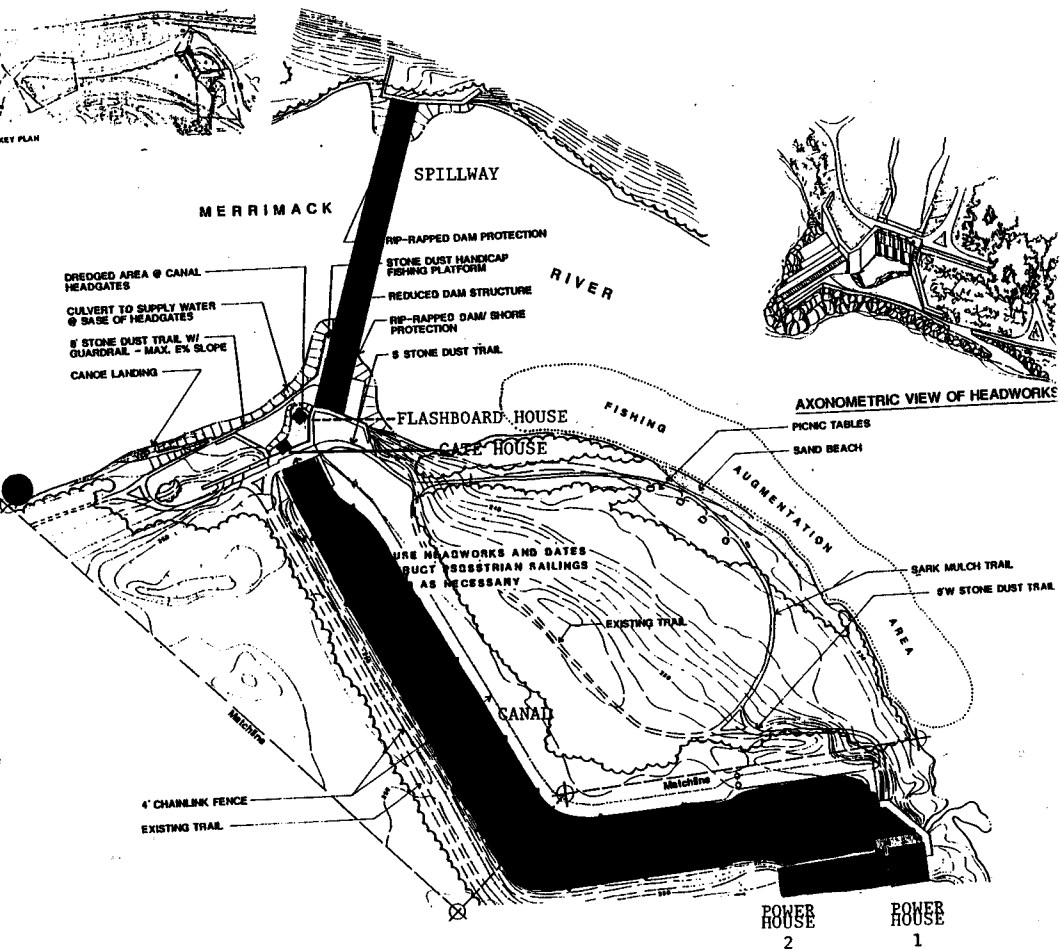
SEWALL'S FALLS HYDROELECTRIC
FACILITY - NPS804

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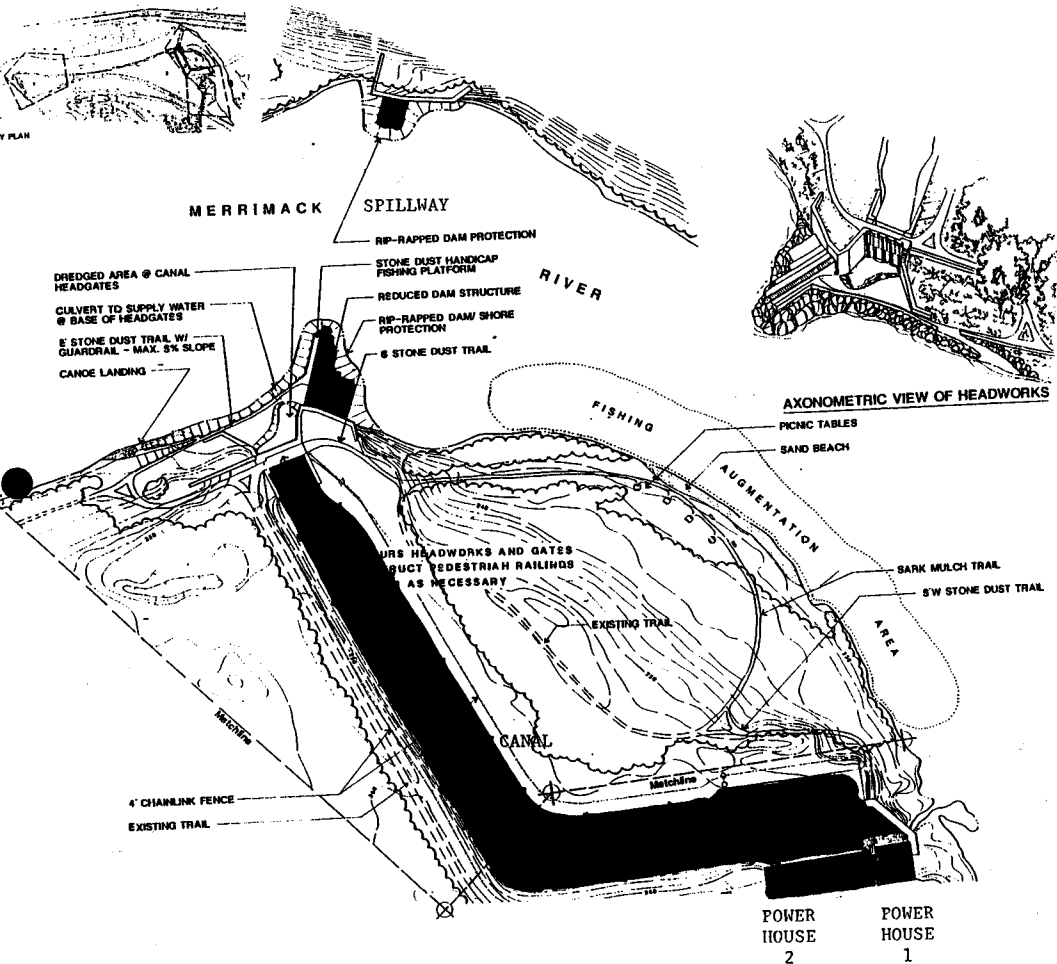
Site Plan 1.
1895: shows spillway, waste gate, canal, and powerhouse 2

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Site Plan 2.
1935: shows spillway, flashboard house, gate house, canal, powerhouse 2, powerhouse 1

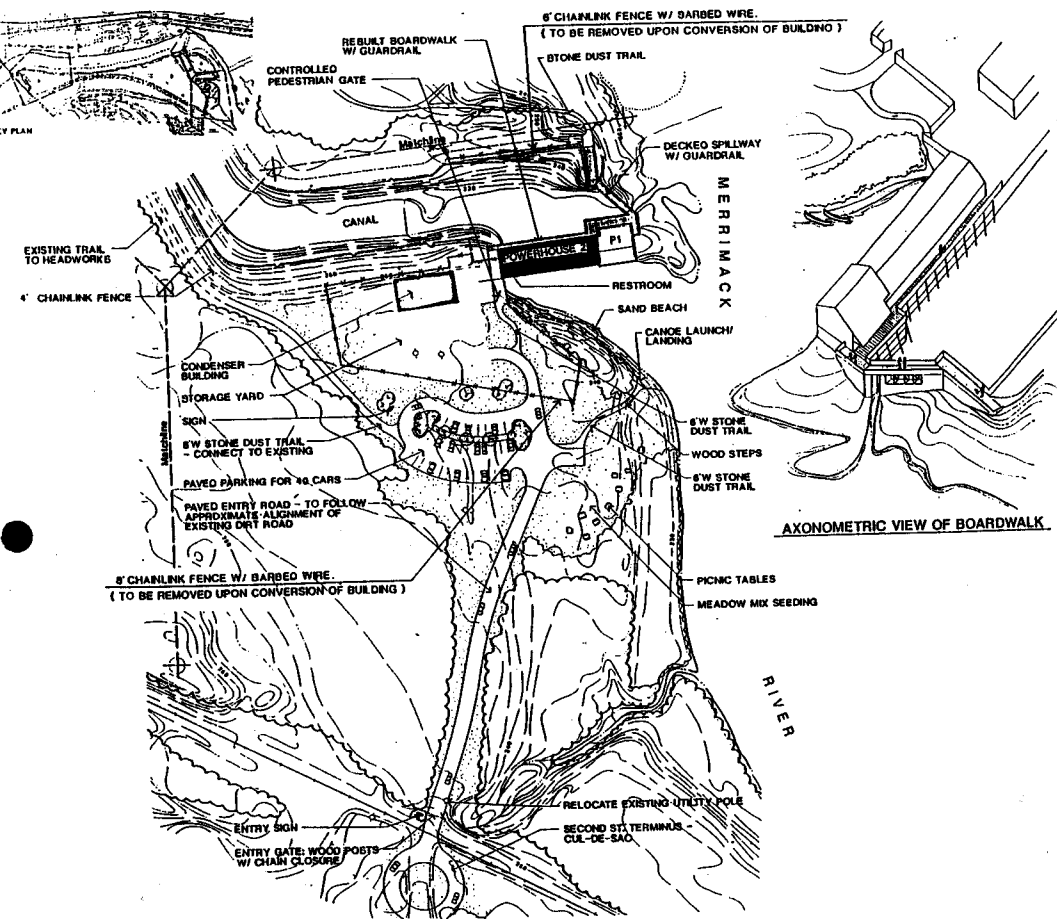
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Site Plan 3.

1993: shows spillway (damaged), canal, powerhouse 1, and powerhouse 2

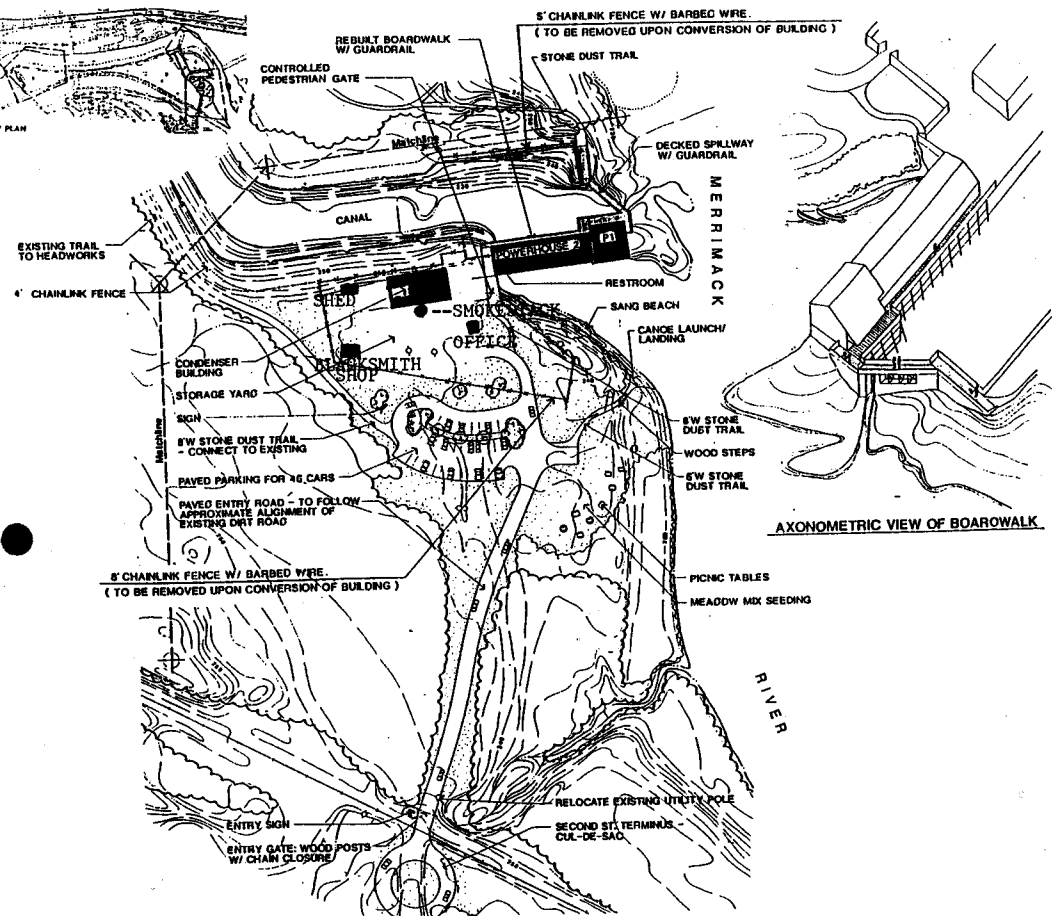
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(Sewall's Falls Dam)
HAER No. NH-20 (Page 17)



Site Plan 4.

1895: shows powerhouse 2 and canal

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(Sewall's Falls Dam)
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Site Plan 5.

1935: shows condenser building (with smokestack), powerhouse 1, powerhouse 2, office, shed, blacksmith shop, and canal

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1993: shows condenser building, powerhouse 1, powerhouse 2, office, shed, blacksmith shop and canal